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Center for Public Policy Innovation

Futurist Policy Initiative: Internet of Everything

SPECIAL REPORT
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Introduction

We live in the most innovative time in human history, with advances happening all around us. The Internet of Everything (IoE) represents a revolution in connectivity that is happening as we speak. IoE is defined by the bringing together of people, process, data and things to make networked connections more relevant and valuable than ever before- turning information into actions that create new capabilities, richer experiences, and unprecedented economic opportunity for businesses, individuals, and countries.[i]

On November 7, 2013, the **Center for Public Policy Innovation** (CPPI), a not-for-profit educational think tank, hosted a policy forum on Capitol Hill for congressional staff, federal agency officials, industry experts and the media entitled ***Futurist Policy Initiative: Internet of Everything.*** Throughout the event, which was co-sponsored by **Cisco**, a world leader on the Internet of Everything, experts from government and the IT industry outlined key policy and regulatory areas they believe will have the greatest impact on helping to foster the future advancement of IoE, the next global wave of innovation worth an estimated $14.4 trillion in global economic value over the next decade. [ii]

The event marked the launch of CPPI's ***Futurist Policy Initiative***, a series of programs dedicated to educating policymakers on transformational technology. "We decided to begin our Futurist Policy Initiative by focusing on the Internet of Everything because so many of the exciting innovations on the horizon, from autonomous vehicles, to game changing advances in health IT, are a part of the IoE phenomenon," remarked CPPI President, **Chris Long**.

Virginia Senator Mark Warner delivered keynote remarks during the event, underscoring the importance of innovation and bipartisanship to create an ecosystem where new technologies can thrive.

Senator Mark Warner delivers keynote remarks

Jeffrey Campbell, Vice President, The Americas of Global Government Affairs at Cisco, moderated the first of its kind policy discussion on Capitol Hill with: **Ramtin Attar**, Principal

Research Scientist at Autodesk, **David Malkin**, Director of Policy, for GE Digital Energy, and world renowned IoE expert **Dan Caprio** of McKenna Long & Aldridge (and Member of the European Commission Expert Group on the Internet of Everything).

CPPI's panel presented a series of examples of how IoE will revolutionize various industrial sectors while identifying and expanding on some of the policy areas impacting the success of IoE. Thus far, the policy discourse revolves around the need to free up additional spectrum (mainly government held spectrum), standardization and interoperability, privacy, and security.

To be sure, the Internet of Everything presents exponential economic, societal, and environmental promise, but to reach its full potential, this transformational technology will require smart public policy that enables American innovation in this next era of connectivity.

The Next Revolution

In order to understand the policy implications surrounding the Internet of Everything, it's important to understand what this transformational technology is. Many are calling IoE the next evolution of the Internet as the cost of sensors drops and more connected devices and objects become uniquely identifiable. It is predicted that within five years, most homes will have 200 devices linked to the Internet, from light bulbs to washing machines.[iii] Cisco estimates that by 2015 there will be 25 billion devices connected

Highlights

- **The Internet of Everything is the next evolution of the Internet, connecting people, processes, data, and things.**
- **The Internet of Everything represents the cutting edge of the next global wave of innovation.**
- **Cisco estimates that by 2015 there will be 25 billion devices connected to the internet and 50 billion by 2050.**
- **Analysis conducted by Cisco estimates there is as much as $14.4 trillion of potential economic value at stake for global private-sector businesses over the next decade.**
- **GE estimates that the Industrial Internet will save industry as much as $150 billion annually through greater efficiency.**
- **The Internet of Everything will impact a variety of sectors, from healthcare, to manufacturing, to transportation, and more.**
- **The Internet of Everything will usher in a new era of innovation, leading to new business formation and jobs creation.**
- **Policy areas surrounding the Internet of Everything include:**
  - o Spectrum-In order for IoE to succeed, more spectrum is required. The largest block of spectrum is currently held by the government. As demand for spectrum grows with IoE, so will the tug of war over spectrum between the public and private sectors.
  - o Privacy & Security- Current privacy principals should be updated to apply global interoperable concepts balanced with the need to accommodate local cultures and governance structures. Policy around privacy and security should also avoid focusing on hypothetical or imagined harms.
  - o Standardization & Interoperability-To facilitate Internet of Everything deployment, interoperability and standards are necessary. Open standards among IoE devices and technology must be driven by industry experts, utilizing the effectiveness of current global standards-setting organizations that involve industry and government collaboration.

Moderator Jeffrey Campbell, Vice President of The Americas Global Affairs, Cisco

to the Internet worldwide, and 50 billion by 2020.

Presently, IoE is composed of a loose collection of disparate, purpose-built networks. As IoE evolves, these networks and more will become connected with increasing analytical and management capabilities. According to a recent Cisco white paper, "the next wave of growth will come through the confluence of people, process, data and things -- or the Internet of Everything." [iv]

"I love the name, 'Internet of Everything,'" began Senator Warner, co-founder of Nextel. "A report in 1982 said that it would take America 30 years to build a wireless network. And at the end of those 30 years, wireless market penetration would be 3-5%," recalled the Virginia Senator, who went on to note the actual impact of wireless communications, and the resulting American expansion that took place in the 1990s and the early part of 2000s.

Campbell remembered first hearing about the IoE phenomenon. "Internet of Everything is an interesting name…When we started talking about this stuff years ago we talked about machine to machine communication. Then we moved to the Internet of Things such as the refrigerator that knows I need fresh milk, which is an example of machine to people…When we talk about IoE today, we are moving on to how people, machines, and networks all interact together for richer experiences. It explains the expansiveness of what we're talking about here," said Campbell.

Meanwhile, GE uses the moniker "Industrial Internet" to describe this burgeoning era of connectivity. Malkin explained, "If you think about it, the world has experienced a series of innovation 'waves' during the past several hundred years. In the mid-1700s, we witnessed the onset of the 'Industrial Revolution' beginning with the invention of the steam engine, followed by the internal combustion engine, and really defined by the rise of industrial enterprises which utilized these machines to achieve tremendous economies of scale."

"If we fast forward to the 1950s, the global economy witnessed the second wave of innovation - the 'Internet Revolution'- marked by the invention of the computer and subsequent rapid improvements in computing power. This period also gave rise to the Internet and distributed communications platforms, which drove down the costs of commercial transactions and social interactions. We are now on the cusp of a third wave of innovation, which is defined by the

melding of the global industrial systems made possible by the Industrial Revolution with the open computing and communications systems developed during the 'Internet Revolution.' This is what GE calls the 'Industrial Internet,'" continued Malkin.

The Industrial Internet, or the Internet of Everything, is driven by technological trends like dramatic increases in processing power, storage, and bandwidth at ever-lower costs; the rapid growth of cloud, social media, and mobile computing; the ability to analyze Big Data and turn it into actionable information and an improved ability to combine technologies in more powerful ways.

Furthermore, barriers to connectedness are dropping as evidenced by IPv6 overcoming the IPv4 limit by allowing more people, process, data, and things to be connected to the Internet (IPv6 creates enough address capacity for every star in the known universe to have 4.8 trillion addresses). [v]

Economic, Societal, and Environmental Promise of the Internet of Everything

Just as the era of mobility made way for new business formation, the innovation born of IoE will lead to jobs creation and opportunities that we can't even begin to imagine today.

"There is a fear out there that as we rely more on computers to do work previously done by humans, workers will be rendered obsolete,

GE's David Malkin discusses the economic impact of IoE on industry

but nothing is further from the truth," opined Malkin. "This is about taking the distributed capabilities and getting the right data to the right people at the right time to improve the industrial operations workers are responsible for."

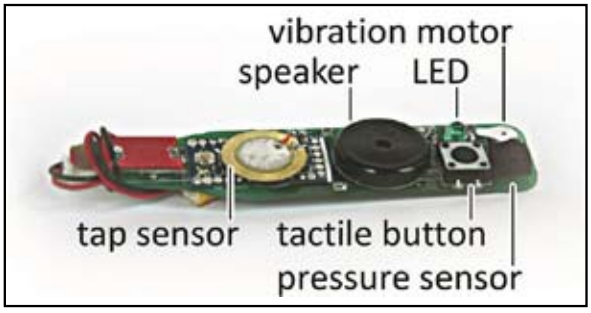
Malkin went on to note the immense effect IoE will have on the economy, even by the most conservative estimates. "If the Industrial Internet can deliver even a 1% improvement in operations—that alone can deliver tremendous global

Industrial Internet: The Power of 1 Percent

What if... Potential Performance Gains in key Sectors

Industry	Segment	Type of Savings	Estimated Value Over 15 Years (Billion nominal US dollars)
Aviation	Commercial	1% Fuel Savings	$30B
Power	Gas-fired Generation	1% Fuel Savings	$66B
Healthcare	System-wide	1% Reduction in System Inefficiency	$63B
Rail	Freight	1% Reduction in System Inefficiency	$27B
Oil & Gas	Exploration & Development	1% Reduction in Capital Expenditures	$90B

Credit: GE Report; "Inustrial Internet: Pushing the Boundaries of Minds and Machines" by Marco Annunziata [vi]



Credit: Autodesk

Credit: Autodesk

economic value. In aviation, a 1% reduction in fuel costs through improved flight planning and engine operations can deliver savings to the industry of $30 billion over 15 years. In the energy sector, a 1% improvement in the performance of gas-fired power through advanced fleet-wide monitoring and diagnostics can yield savings of $66 billion over 15 years. All told, GE estimates that the Industrial Internet has the potential to save $150 billion annually across all industries. This isn't going to happen on its own; it will take the collective efforts of vendors, policymakers, and others to build a platform that allows us to deliver value."

"On the Hill the value of money is thrown around, a billion here a billion there, but with IoE we are talking real money. We are looking at the possibility of world economic growth, if we can really harness this thing going forward," observed Campbell.

The economic growth from IoE will come to fruition as the technology creates greater efficiency and capabilities among variety of sectors. CPPI's panelists discussed some real world technologies categorized as part of the IoE phenomenon:

Healthcare

Breakthroughs in healthcare driven by IoE will change the patient doctor relationship allowing for real time health monitoring. For example, Campbell told attendees about FDA-approved ingestible chips the size of a grain of sand that are integrated into pills that use body fluids to activate and send signals to smartphones, alerting doctors that medicine has been taken.

The **Scanadu** "tricorder" measures blood pressure, temperature, electrocardiograms (ECG), oximetry, heart rate, and breathing rate by holding the device to your temple for ten seconds. That data is then sent to a smartphone via Bluetooth.

Campbell also mentioned how the **DuoFertility** monitor uses IoE to help couples get pregnant. The skin patch tracks fertility status, sends data wirelessly to the DuoFertility reader, allowing the patient to know when they can conceive. At the same time, specialists monitor data through an online service for customer counseling.

Autodesk Research has been exploring the logistics and challenges of sub-dermal user interfaces, or electronic feedback devices implanted beneath the user's skin. Attar told the forum

how researchers have tested over a dozen user interface implants that can employ input devices, including microphones for audio; buttons, pressure sensors and tap sensors for input via direct touching of the skin, and more. These sub-dermal interfaces could wirelessly communicate with devices like Google's augmented reality glasses, and could also help people control other devices in their bodies. Medical implants exist today, but there aren't many ways to easily retrieve the status of these devices, get real time information about your health, or control doses of various drugs.[vii]

Manufacturing

In manufacturing, the potential for cyber-physical systems to improve efficiency in the production process and the supply chain is vast. Imagine processes that monitor themselves, where smart products can take action to avoid damages or correct themselves, and where individual parts are automatically restored.[viii]

Campbell used the Coco-Cola Company as an example of IoE technology increasing production efficiency. "Coke is a major global producer, and focused on being more efficient. There is a supply chain responsiveness system used by the company to orally transmit orders. Systems capture data, figure out where to have products/item filled- they even have automatically generated shipping labels put on at the end [of production]," remarked Campbell.

Transportation

Long term, IoE gives the transportation industry an opportunity to connect people, provide greater safety, communicate more effectively, and transform transportation centers into community hubs.[ix]

Campbell described how Volvo is putting sensors in cars that measure events as they happen in real time. These sensors communicate information back to the network that is related both to the safety and efficacy of the car. If systems are failing sooner than expected, the car can proactively predict where there will be issues.

The transportation industry will transform even further as autonomous vehicles reach the market place. Self-driving cars have the potential to bring the average number of fatalities from motor vehicle accidents from 43,000 down to virtually zero.

Energy

The Industrial Internet brings advanced analytics that deliver meaningful outcomes for industry, while improving productivity, reducing fuel costs, and ultimately providing greater energy efficiency. As sensors provide more and more information about how energy is used, more precise and efficient delivery mechanisms born

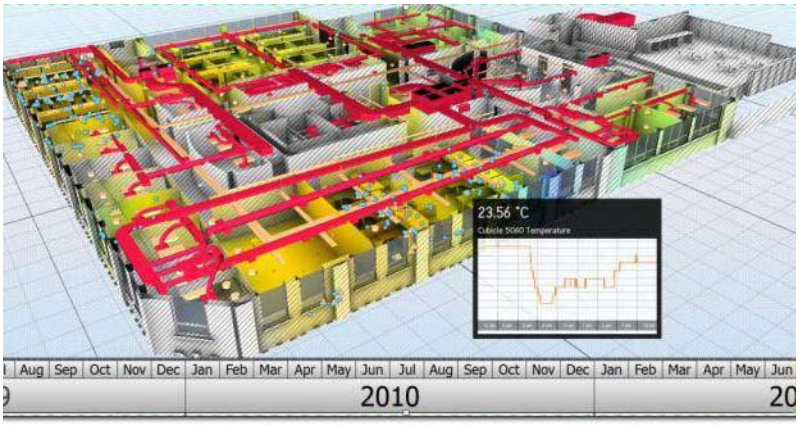
Audience of congressional staff, federal agency officials, and industry attend the first of its kind forum on Capitol Hill

of IoE will not only lower costs, but help protect the planet's resources.

For instance, a single GE jet engine is embedded with 20 sensors and generates a terabyte of data per day. A single blade in a GE gas turbine can generate 500 GB of data in a single day. Malkin explained how one utility – PSEG – is using these and other data to monitor its fleet of gas turbines and real-time and adjust operation in response to changing conditions on the grid. Already, PSEG is reporting a 6 % increase in output and a 1.5 % reduction in fuel usage.

Building Automation

Building Information Modeling (BIM) is an intelligent model-based process that provides insight for creating and managing building projects faster, more economically, and with less environmental impact. **Project Dasher** is an Autodesk research project that uses BIM-based modeling along with meter and sensor data to provide building owners greater understanding of real-time building performance throughout the life-cycle of the structure.



Credit: Autodesk

Attar explained how buildings themselves can become living laboratories for technology. "We've created a digital information model which is essentially a sophisticated model of all existing assets in our Autodesk office building. We instrumented about 30 cubicles in the office with six sensors each, turning each cubicle into a data collection mechanism. We can begin to imagine a future where all the furniture is instrumented and we are actually using chairs, tables, and more, equipped with sensors capable of gathering data," said Attar.

Many buildings today are equipped with sophisticated systems that collect data from thousands of endpoints, allowing building managers to maintain buildings by minimizing long-term operational costs. But Autodesk saw the need for a more integrative approach, striking a balance between energy saving measures and occupant comfort. By employing BIM, Project Dasher goes beyond existing building dashboards for a more comprehensive method of monitoring performance. Project Dasher acts as a visualization hub where data collected from various sources is aggregated and presented in 3D to enhance our ability to infer more complex causal relationships pertaining to building performance and overall operational requirements.

Education

The era of connectivity is also facilitating the democratization of education, driving changes in higher education as evidenced by the rising popularity of Massively Open Online Courses (MOOCs) like **Coursera**, **Udacity**, and **Ameri-**

can Honors. These online curricula offer students more focused courses at significantly lower costs than traditional four year institutions. Although many colleges look down on MOOCs, some, like George Mason University and Georgia Tech, are embracing them, the later offering a master's degree in computer science for only $7,000.[x]

"We've almost reached a limitless amount of capability to bring information to bear on the problems of the world..."
-Campbell

"Technology can really transform education. It's important for our workforce of tomorrow, that they be willing and able to work in the fields of technology in the future. We want to use technology to teach people, but also to expose children to technology at a younger age. Kaplan University uses online technology to change the accessibility of material to students, and the kind of interactivity that is available… Teachers can talk to students remotely, in small groups, or one on one, without actually having to physically get together," said Campbell.

Technology-based education makes online classes easy to access and use, allowing students to navigate lessons, explore web field trips, and communicate with fellow students and faculty via email, IM, and message boards. "Essentially, technology will allow all the knowledge of the world to reach any individual student, and that's really important if we want to improve the American education system," Campbell pointed out.

Agriculture

Farmers are already benefiting from automation, from harvesting crops to intricate irrigation systems. Campbell described how the agriculture industry will further benefit from technological advances. "We've hit a point where we are literally throwing computer chips into the soil so they can provide information back to the network that can dramatically increase the production of a piece of farmland while decreasing the amount of resources needed to grow the crop-whether it's water, or fertilizer, or insecticides. It's really astounding that we've almost reached a limitless amount of capability to bring information to bear on the problems of the world, and that is what the Internet of Everything will be about going forward." said Campbell.

Policy Areas Surrounding the Internet of Everything

While policy related to the Internet of Everything is still emerging as the technology advances, panelists were able to identify key policy areas impacting the successful adoption of IoE across the United States, and the world. To date, those issues center on the need for spectrum, standardization and interoperability, and concerns over privacy and security. Until CPPI's policy forum, these issues had yet been considered by Washington policymakers in the context of the Internet of Everything.

Thanks to IoE thought leaders like Dan Caprio, a member of the European Commission IoE Expert Group, a much needed dialogue on IoE has begun taking shape across other parts of the world. "This is a monumental occasion for me; I've spent a decade working on IoE, mostly in Europe. This is the first time I've gotten to talk about this on Capitol Hill," Caprio remarked. Caprio has been asked to speak during the Federal Trade Commission's first workshop on IoE at the end of November.

Caprio continued, "The Internet of Everything is transformative. It promises to revolutionize. The real opportunity and challenge is how to protect privacy and security while enabling innovation. As we begin this policy discussion we really are at the beginning of the beginning."

The current policy landscape around the Internet of Everything is concentrated on the following issues:

Spectrum

First and foremost, IoE requires spectrum. As more and more devices become connected to each other and the Internet, the demand for spectrum will rise. At this time, the government owns the biggest chunk of spectrum, and as IoE demands more, the tug of war between the public and private sectors over spectrum will become more complex.

Senator Warner was emphatic in his call for better spectrum management during his keynote remarks. "The government is the greatest owner of spectrum. Trying to get a spectrum inventory should be low hanging fruit, but it hasn't been done. We have to keep the pressure on the public sector to free up spectrum. We also need to be more creative in freeing up spectrum for private sector uses, perhaps with incentive auctions," said the senator.

In a June 14, 2013 **memorandum**, President Barack Obama ordered an inventory of federal spectrum use to agency heads. The order is part of a larger administration plan to free up 500 megahertz of spectrum from the public and private sector to allocate to mobile broadband.

However, the inventory will not be a public-facing database, and for security purposes, much of the information detailing the nature of federal spectrum use will remain under wraps.[xi]

Privacy and Security

From a societal perspective, as with many new technologies, fears of hypothetical harms tend to dominate the discourse. As Adam Thierer, of George Mason University Mercatus Center writes:

Despite the worst-case scenarios and hypothetical fears, individuals adapted in almost every case and assimilated new technologies into their lives. This is true even for new devices and services that initially raised very serious privacy concerns. As technology author Larry Downes has observed, "After the initial panic, we almost always embrace the service that once violated our visceral sense of privacy." [xii]

During his remarks, Senator Warner stressed the importance of maintaining a healthy dialogue about privacy and cybersecurity. "The last thing the IT industry wants is another government regulator adding additional costs. I continue to fear what could happen on the cyber side if we don't have agreed upon standards, whether its utilities or another industry," said the longtime champion of innovation, who suggested these discussions take place now, before "something happens" and Congress hastily overacts in crafting legislation.

Caprio also called for the private and public sectors to engage in discussions to better understand this transformational technology. "The Internet of Everything is multifaceted and complex, with many different stakeholders, making it very difficult to define, comprehend and govern. It also means that there's no comprehensive, one-size-fits-all vision or model for the Internet of Everything. Security and privacy are critical elements of the Internet of Everything, and without high standards, consumer and societal trust can be easily violated. As technology stores more data, we face an increased threat of exposure of information," stated Caprio. "We need to ask ourselves what we need to protect, and how should we protect it."

A key component in IoE development and implementation is user trust, particularly as this technology utilizes increasing levels of personal and non-personal data. Caprio suggested the notion of "Notice of Choice," or a move away from a silo approach to privacy. "We really need to update the current privacy principals to apply global interoperable concepts, balanced with the need to accommodate local cultures and governance structures," explained Caprio who also highlighted the significance of approaching privacy policy in a real world context while avoiding hypothetical harms.

Moreover, Caprio encouraged lawmakers to work with industry in addressing some of the major issues while avoiding prescriptive legislative security initiatives that stand to lose relevance because of technology's pace of advancement. In a recent law review article, Caprio writes that companies should be encouraged to determine appropriate security requirements for specific applications up-front when designing architectures along with security requirements and consensus based interoperable standards.[xiii]

Interoperability and Standardization

Currently, most applications of the Internet involve at least some human interface and are composed of a relatively homogenous set of devices (smartphone, laptops, high-end servers, etc.). According to research by Ericsson, IoE will create interoperability challenges such as a capability mismatch between traditional Internet hosts and small devices; widely differing communication and processing bandwidths in different devices; needs for interoperability at a semantic level; and different internet working protocol choices.[xiv]

To facilitate IoE innovation and deployment, in-

CPPI President Chris Long calls for continuing engagement with policymakers for better understanding of emerging technologies

teroperability and standards are necessary. Open standards among IoE devices and technology must be driven by industry experts, utilizing the effectiveness of current global standards-setting organizations that involve industry and government collaboration, according to Caprio.

Conclusion

Although IoE offers limitless promise, its potential will not be fully realized unless policymakers understand what the Internet of Everything is and their role in allowing the technology to advance. While the European Union has begun preparing for the technology's ubiquitous deployment, the United States has yet to embark on such a comprehensive approach.

The FTC plans to better grasp the opportunities and challenges to IoE adoption in the United States during its November workshop. Caprio applauds this move as a fact finding exercise for the FTC to educate itself, rather than the beginning of a regulatory inquiry.

By engaging policymakers and their staff on the economic, societal, and environmental importance of IoE, policy concerns can be met with enlightened public policy that fosters technological advancement. IoE will give rise to the next wave of extraordinary innovation and economic opportunity, and the United States needs to be at the forefront of this transformational technology.

The Center for Public Policy Innovation will continue engaging stakeholders on Internet of Everything related issues throughout its ***Futurist Policy Initiative***. From the future of healthcare, to the future of transportation, CPPI's educational programing will foster a dialogue around cutting edge innovation in Washington for public policy in sync with the pace of technology.

The Center for Public Policy Innovation (CPPI) is a 501(c)(3) not for profit educational think tank whose mission is to assist government officials in addressing the many challenging issues brought on by the rapid advancement of Information Technology.

CPPI provides policymakers with groundbreaking thought leadership on transformational technology, informed policy analysis, and innovative strategies to help ensure American competitiveness in the global economy and comprehensive security on the homefront.

CPPI convenes educational symposiums, site visits, and other forums that bring together stakeholders from government, industry, academia, and the civic sector to discuss policy issues in a collaborative environment.

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